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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 09/856,823 | 05/25/2001 | Shin Hashimoto | 0819-559 | 3480 |

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| EXAMINER | |
|---|---|
| SONG, MATTHEW J | |
| ART UNIT | PAPER NUMBER |
| 1765 | |

DATE MAILED: 09/01/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) |
|---|---|---|
| | 09/856,823 | HASHIMOTO ET AL. |
| | Examiner | Art Unit |
| | Matthew J Song | 1765 |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *14 June 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *4-8,10 and 17-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *4-8,10 and 17-21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *2/26/2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Information Disclosure Statement*

1. The information disclosure statement filed 2/26/2004 fails to comply with 37 CFR 1.98(a)(2), which requires a legible copy of each U.S. and foreign patent; each publication or that portion which caused it to be listed; and all other information or that portion which caused it to be listed. It has been placed in the application file, but the information referred to therein has not been considered. The Moll et al, Gersey et al, Normand et al and McGregor et al references are not provided.

### *Continued Examination Under 37 CFR 1.114*

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 6/14/2004 has been entered.

### *Claim Rejections - 35 USC § 103*

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 4, 5, 6, 7, 8, 10, 17 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sugano et al (US 4,469,527) in view of Lin et al (US 5,010,037).

In a method of making a semiconductor device, Sugano et al teaches a silicon substrate having a silicon oxide film on the surface thereof was irradiated with thermal neutron beams or other types of irradiation such as high speed neutron beam, $\alpha$ ray, $\beta$ ray, $\gamma$ ray, electron beam or the like, so that lattice defects were produced throughout the silicon substrate to make it semi-insulating (col 2, ln 50-61, col 11, ln 60-67 and col 12, ln 1-5). Sugano et al also teaches the surface of the silicon substrate was annealed by irradiating it with laser beam pulses, so that an activated layer was formed at the surface portion of the silicon substrate (col 12, ln 5-35). Sugano et al also teaches an ion beam or electron beam can be used in place of the laser beam (col 2, ln 50-67). Sugano et al also teaches the activated layer was exposed by removing the silicon oxide (col 2, ln 5-35). Sugano et al also teaches the novel semi-insulating semiconductor structure proved to be useful and can be used in the preparation of a MOSFET (col 13, ln 1-35 and col 14, ln 35-55).

In a method of forming a transistor (col 1, ln 10-15), Lin et al teaches epitaxial $CoSi_2$ films have been grown on Si substrates under ultra-high vacuum conditions using a solid phase reactive epitaxy. Lin et al also teaches a pure cobalt layer is deposited at room temperature onto the substrate and then annealed at an elevated temperature to form epitaxial $CoSi_2$ (col 1, ln 15-25). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Sugano et al's silicon semiconductor substrate by growing a $CoSi_2$ layer on the silicon substrate, as taught by Lin et al, to form a useful metal base transistor (col 1, ln 10-15).

Referring to claim 17, the combination of Sugano et al and Lin et al does not teach distributing a nonmetal element included in compound layer in a region in the vicinity of the surface portion of the semiconductor layer through recoil by irradiating the compound layer with a particle energy beam. The combination of Sugano et al and Lin et al does teach depositing a silicon oxide layer, which reads on applicants' compound layer, and irradiating the layer with a ion beam to anneal the compound layer, which inherently will distribute the nonmetal element in the compound layer through recoil by irradiating the compound layer with a particle beam because the combination of Sugano et al and Lin et al teaches a similar process of irradiating a silicon oxide layer with an ion beam, as taught by applicants, note page 27 of the instant specification. Performing a similar process inherently will produce a similar result, namely the effect claimed by applicants.

Referring to claim 4, the combination of Sugano et al and Lin et al teaches the same semiconductor layer, semiconductor-metal layer and compound layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the

semiconductor-metal compound layer has a face centered cubic structure and the compound layer is amorphous.

Referring to claim 5, the combination of Sugano et al and Lin et al teaches an ion beam, but is silent to the beam including a nonmetal element. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Sugano et al and Lin et al by including a nonmetal element such as argon.

Referring to claim 6, the combination of Sugano et al and Lin et al teaches the same semiconductor layer and semiconductor-metal layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure.

Referring to claim 7, the combination of Sugano et al and Lin et al teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures. It is inherent that the semiconductor layer has a diamond or zinc blend structure and the semiconductor-metal layer has a calcium fluoride structure because the combination of Sugano et al and Lin et al teaches the same layers as applicant.

5. Claims 4, 5, 6, 7, 8, 10, 17 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sugano et al (US 4,469,527) in view of Lin et al (US 5,010,037) as applied to claims 4, 5, 6, 7, 8, 10, 17 and 19 above, and further in view of Yamazaki et al (US 5,930,608).

The combination of Sugano et al and Lin et al teaches all of the limitations of claim 5, as discussed previously, except the combination of Sugano et al and Lin et al does not teach the particle energy beam includes a nonmetal element.

In a method of manufacturing a semiconductor device, note entire reference, Yamazaki et al teaches in the case of laser annealing, an argon ion laser, $CO_2$ laser or other similar laser can be employed (col 4, ln 50-55). Yamazaki et al also teaches a laminate was laser annealed by irradiation of an argon ion laser beam (col 5, ln 50-60).

The combination of Sugano et al and Lin et al teaches annealing the surface of silicon substrate by irradiating it with laser beam pulses, but silent to the type of laser beam pulses used. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Sugano et al and Lin et al by using any conventionally known laser annealing means, such as the argon ion laser beam, taught by Yamazaki et al to obtain an expected result.

6. Claims 4, 5, 6, 7, 8, 10, 17, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sugano et al (US 4,469,527) in view of Lin et al (US 5,010,037) as applied to claims 4, 5, 6, 7, 8, 10, 17 and 19 above, and further in view of Maa et al (US 5,830,775).

The combination of Sugano et al and Lin et al teaches all of the limitations of claim 18, as discussed previously, except removing the compound layer by irradiating the compound layer with a particle energy beam.

In a method of making a semiconductor device, Maa et al teaches an in-situ argon ion beam clean is recommended for removing surface oxides and other types of ion beam cleaning, this reads on applicants' particle beam, or similar process may be used to accomplish the removal of surface oxide (col 6, ln 50-65).

The combination of Sugano et al and Lin et al teach removing the silicon oxide film, but is silent to the method used to remove the oxide. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Sugano et al and Lin et al by using any conventionally known means for removing oxide, such as the argon ion beam cleaning taught by Maa et al to produce an expected result.

***Allowable Subject Matter***

7. Claim 21 is allowed.

8. Claims 20 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

9. The following is an examiner's statement of reasons for allowance: The closest prior art is Sugano et al (US 4,469,527). Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide layer with laser beam pulses to anneal the surface of the silicon substrate (col 11, ln 65 to col 12, ln 10). Sugano et al does not teach distributing a nonmetal element included in the compound layer in the region in the vicinity of the surface portion of the semiconductor layer through recoil. However, this feature would be inherent to Sugano et al because Sugano et al teaches a similar method of depositing a compound layer and irradiating the compound layer, as applicant. Sugano et al does not teach or suggest the concentration of the nonmetal element per unit area is between $4x10^{14}$ $cm^{-2}$ and $4x10^{15}$ $cm^{-2}$.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

10. The following is a statement of reasons for the indication of allowable subject matter: The closest prior art is Sugano et al (US 4,469,527). Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide layer with laser beam pulses to anneal the surface of the silicon substrate (col 11, ln 65 to col 12, ln 10). Sugano et al does not teach distributing a nonmetal element included in the compound layer in the region in the vicinity of the surface portion of the semiconductor layer through recoil. However, this feature would be inherent to Sugano et al because Sugano et al teaches a similar method of depositing a compound layer and irradiating the compound layer, as applicant. Sugano et al does not teach or suggest the concentration of the nonmetal element per unit area is between $4x10^{14}$ $cm^{-2}$ and $4x10^{15}$ $cm^{-2}$.

***Response to Arguments***

11. Applicant's arguments with respect to claims 4-8, 10 and 17-21 have been considered but are moot in view of the new ground(s) of rejection.

12. Applicant's arguments filed 6/14/2004 have been fully considered but they are not persuasive.

Applicants' argument that Sugano et al does not teach distributing oxygen atoms in the vicinity of the surface of the semiconductor layer using recoil of the particle energy beam is noted but is not found persuasive. The Examiner admitted in the rejection that Sugano et al does not explicitly teach distributing oxygen atoms in the vicinity of the surface of the semiconductor layer using recoil of the particle energy beam. However, the Examiner maintains that oxygen is inherently distributed because Sugano et al teaches depositing an oxide layer and irradiating the oxide with a laser beam, an electron beam or an ion beam (col 2, ln 55-68 and col 12, ln 1-10), which reads on applicants' particle beam. Sugano et al teaches a similar method of irradiating an oxide layer with a particle beam, as applicants, note instant claim 10; therefore distribution of oxygen atoms inherently occurs.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., distributing oxygen atoms (pg 9) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Sugano et al does not teach forming a cobalt silicide, which the Examiner admitted in the rejection. Sugano et al is not relied upon as a teaching for this feature. Lin et al teaches forming a cobalt silicide on a silicon substrate.

***Conclusion***

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Miura et al (US 6,3346,465) teaches an epitaxial cobalt silicide is obtained by heat treating a cobalt film on a surface of a single crystal silicon substrate and the epitaxy of the $CoSi_2$ is due to the fact that Si and $CoSi_2$ have approximately the same lattice constant (col 1, ln 50-65).

Zeininger et al (US 5,780,929) teaches silicides provide low sheet and contact resistance in MOSFETs (col 1, ln 20-30) and $CoSi_2$ **3** formation on a silicon substrate **2** (col 2, ln 25-35 and Claim 1).

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1765

MJS

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER